



Aerial Mapping of female *Ailanthus altissima* trees in Ohio mixed oak forests.

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Abstract

Ailanthus altissima (tree-of-heaven) is a highly invasive tree that is present in many forested landscapes in the eastern U.S. Managers often observe an expansion in *Ailanthus* populations following forest disturbances such as harvesting and prescribed burning. A single female *Ailanthus* tree can produce 350,000 seeds, which are commonly wind-disseminated distances exceeding 100 to 200 meters. A cooperative research project was initiated to study the distribution and abundance of *Ailanthus* within the highly dissected landscape of Tar Hollow State Forest in southeastern Ohio. We employed geo-referenced digital aerial sketch mapping technology in a low-flying helicopter to identify female trees (seed-producers) and patches (non-seeders) of *Ailanthus* in winter 2008, when persistent seeds are highly visible. The method appears to be an effective way to survey for seed-producing *Ailanthus* across a landscape. During a two hour flight, 99 seed-bearing females and 42 patches, ranging in size from 0.18 to 13.4 ha were identified within a 3885 ha (9600 acre) area. Seventy percent of the aerially-identified females were ground-truthed using hand-held GPS units; 4.3% were either misidentified or not located. Starting in summer 2009, sampling of individual trees as well as a systematic grid will quantify *Ailanthus* abundance and demography in relation to management practices and landscape/stand attributes, to better understand and model the key factors related to the presence, abundance, and spread of *Ailanthus*. The direct effects of prescribed fire and herbicide treatments on *Ailanthus* demography and spread will also be studied.



The topography of Tar Hollow State Forest is highly dissected, consisting of sharp ridges, steep slopes, and narrow valleys. Cost-effective and efficient use of on-ground reconnaissance of female *Ailanthus* trees across this 3885 ha area was deemed improbable.

Research Approach

- We hypothesized that prominent seed clusters, often >800 per tree (Illick & Brouse 1926), which persist through the winter would be easily identifiable in aerial surveys; and that distance from seed trees will be an important factor in predicting the abundance of *Ailanthus* within the landscape.
- Aerial surveys were conducted by Ohio Department of Natural Resources, Division of Forestry personnel on Dec. 11, 2008 using digital aerial sketch mapping (DASM) from a helicopter.
- A proportion of aerially-identified female trees were ground-truthed in January-February 2009, using hand-held GPS units. In addition, tree and site data were collected at each tree (see Ground-truthing Data Collection).
- Identified patches with seed-producing trees are being incorporated into a GIS that already has multiple layers for the study area, including soils, 10-m digital elevation model, Integrated Moisture Index (Iverson et al. 1997), forest management history, prescribed fire, imagery, and various landscape features.

Aerial Surveys



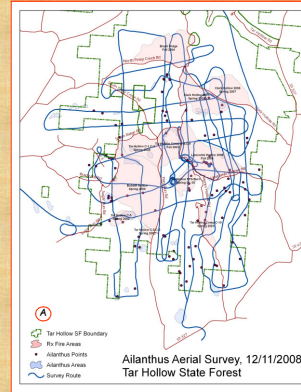
Identification of seed-bearing female trees across the landscape during dormant season



ODNR Helicopter

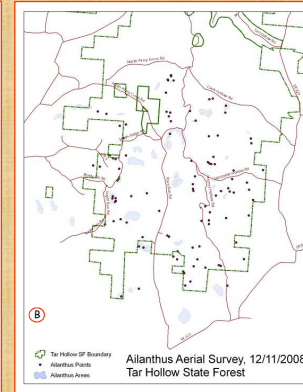
GPS and Digital Aerial Sketchmapping System

GPS and digital aerial sketch mapping technology were used to map the location of adult female trees and patches of vegetative *Ailanthus* during the dormant season



Area surveyed: 3885 ha (9600 acres)
Flight time: 2 hr 17 min

- Flight path of helicopter (blue survey route).
- 99 individual seed-bearing trees (*Ailanthus* points), and 42 vegetative patches (*Ailanthus* areas) were mapped during the helicopter fly-over.



Ground Truthing



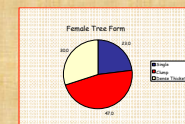
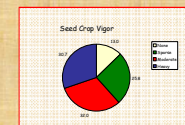
Ground truthing of the aerially-identified females using hand-held GPS units

Ground Truthing Data Collection

- DBH (cm) largest and 2nd largest
- Female *Ailanthus*
- Seed crop vigor rating: None, Sparse, Moderate, or Heavy
- # Females within 5m
- Tree form: single tree, clump, or dense thicket
- Slope (%) and Aspect (deg)
- Distance (m) to nearest female, skid road or ridge top
- Evidence of logging activity, Rx burn, landing, or home settlement

Summary of Ground Truthed *Ailanthus*

Trees ground-truthed (%)	70
Trees misidentified or not located (%)	4.3
Mean dbh largest female (cm)	19.2 ± 0.9 (7.5 in)
Range dbh largest female (cm)	3.0 - 38.1 (1.2-15 in)
Size range of vegetative patches (ha)	0.18 - 13.4 ha (0.4 to 33 acres)



Literature Cited

- Illick, J.S., and Brouse, E.F. 1926. The *Ailanthus* tree in Pennsylvania. Pennsylvania Department of Forestry and Water Bulletin 38:1-29.
- Iverson, L.R., Dale, M.E., Scott, C.T., and Prasad, A. 1997. A GIS-derived integrated moisture index to predict forest composition and productivity of Ohio Forests (U.S.A.). Landscape Ecology 12:331-348.
- Prasad, A. M., L. R. Iverson, and A. Liaw. 2006. Newer classification and regression tree techniques: bagging and random forests for ecological prediction. Ecosystems 9:181-199.

GIS Modeling

Goal - Produce a model of key factors related to the presence and abundance of *Ailanthus* across the landscape.



GIS and Statistical Modeling

Data collected on 400-m systematic grid of 280 plots across landscape:

- Abundance & demography of *Ailanthus*
- Light levels
- Past fire intensity
- Management history
- Distance/direction from seed-producing trees
- Slope, aspect, soils, Integrated Moisture Index, 10-m digital elevation model, overstory basal area, etc.

Statistical tools will include classification and regression trees (CART) and Random Forests (Prasad et al. 2006) to better understand and test a general model of *Ailanthus* distribution and abundance in a heterogeneous landscape.

Summary and Future Work

- Survey method shows promise as efficient method to locate females for herbicide treatment
- Provide forest managers with an efficient tool to eliminate *Ailanthus* populations in advance of silviculture treatment (e.g. prescribed fire or timber harvest)
- Elimination of potential propagules from the landscape with the removal of seed-bearing females
- Additional project work includes:
 - document the direct effects of prescribed fire on the demography of *Ailanthus* populations
 - explore the use of pre-burn herbicide applications to mitigate the risk of *Ailanthus* expansion after fire

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Mature alanthus seeds are thin twisted samaras, papery thin, light brown in color, and 2.54-3.8 mm (1-1.5 in) long. They are wind-dispersed, numerous, and persist throughout the dormant season. Sámara photo courtesy of USDA-NRCS PLANTS Database.

Objectives

- Determine how the distribution and abundance of *Ailanthus* is related to recent fires, other management activities, seed sources, and landscape features.
- Develop a standardized, cost-effective methodology to map the location of seed-producing *Ailanthus* using aerial surveys during winter months.



Study Area

Tar Hollow State Forest, at 6524 ha (16,120 acre), is the third largest State Forest in Ohio. It is a mixed oak forest with *Ailanthus* present in many areas. It is located within the Southern Unglaciated Allegheny Plateau. The topography is dissected, consisting of sharp ridges, steep slopes, and narrow valleys.

Land Use History

This land has a long history of subsistence farming and human disturbance. The forest originated from a Depression Era Land Utilization project during the 1930s. The purpose of the program was to relocate families to more productive land. The forest has since been managed for timber production, wildlife, and recreational use by the Ohio Department of Natural Resources, Division of Forestry.